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Impact of A Local Food-Based Isotonic Beverage on Post-Exercise Heart Rate in Adolescent Soccer Players in Karawang

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ORIGINAL RESEARCH

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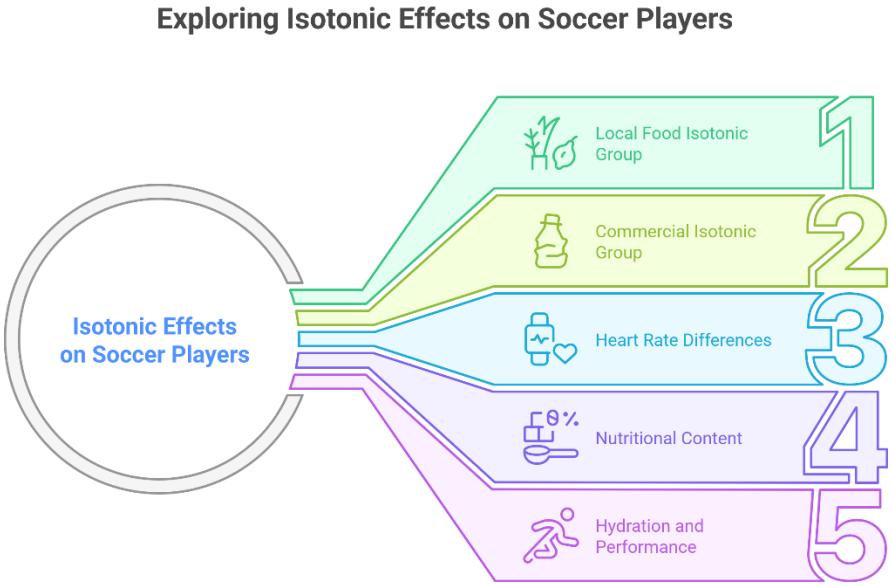
ABSTRACT

The performance of soccer players is affected by their condition, including hydration status. Previous studies have shown that the level of dehydration in adolescent soccer players was very high. Therefore, a strategy was needed to prevent dehydration in soccer players. The purpose of this study was to identify the isotonic effect of using local food ingredients (cucumber, lemon, honey) on the heart rate of adolescent soccer players. The design of this study was a pre-experimental one-shot case study, with a total of 25 participants divided into the Local Food Isotonic (LFI) group and the Commercial Isotonic (CI) group. The results of this study showed that the nutritional content of LFI was similar to CI. The heart rate in the LFI group was significantly different compared to the CI group (p-value=0.005). Therefore, local food isotonic can be used as an alternative isotonic to prevent dehydration and maintain the performance of soccer players. Further research is expected to provide a control group and other variables related to cardiovascular indicators and player performance.

GRAPHICAL ABSTRACT



INTRODUCTION

Soccer is a popular game sport that involves complex play and is a mixture of aerobic and anaerobic. Soccer is a popular game sport that involves complex play and is a mixture of aerobic and anaerobic. Aerobic activities in soccer are low-intensity activities, such as walking and jogging. These activities are usually performed by a defender. While anaerobic in soccer is high intensity, the soccer players traverse around 9-11 kilometers, with 3% sprinting and 5% running at high-intensity levels (Rodríguez-Fernández et al., 2019). Players compete for 90 minutes with this complexity and tend to lose large amounts of body fluids due to energy expenditure and the production of metabolic heat. The high-intensity exercise elevated body temperature (39-40°C), a gradual depletion of carbohydrates and muscle glycogen. Thus, the responses include an increased skin blood flow and allow evaporative heat loss through sweats (Rollo et al., 2021).

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Water makes up 50-70% of body weight. The role of water in the body is fundamental for survival, for example, nourishing electrolyte balance, metabolism of cells, oxygen, and nutrient transportation, support cardiovascular function, and muscle contraction (Fernández-Álvarez et al., 2022). A cross-sectional study revealed that 67.5% of adolescent soccer athletes were dehydrated (Putriana et al., 2024). Recent studies also found a half of youth soccer players were in mild dehydration (King et al., 2024; Klimesova et al., 2022). When the body loses more fluids than it takes in, a condition termed dehydration occurs, then it will disrupt the mineral balance in body fluids. Dehydration increased mineral excretion, especially of sodium, potassium, calcium, and magnesium (Gotthold, 2020).

Previous studies have shown many negative impacts of dehydration on athlete performance. Fortes et.al. (2018) represented there was a significant reduction in the score of GPAI (Game Performance Athlete Instrument), indicating that dehydration mediated the passing decision-making performance of soccer athletes (Fortes et al., 2018). An experimental study of rehydration also performed that moderate dehydration had an impact on the muscle strength of the leg and decreased motor precision of athletes (Cariolo et al., 2019). Palka et al. (2023) found impairment in heart rate variability after exercise-induced dehydration (45 min of exercise) (Pałka et al., 2023). One of the basic pathways in this case is that dehydration can influence the occurrence of hyperosmolality and hypovolemia which will increase the workload of the heart as measured using the heart rate (cardiovascular strain). The increase in heart rate is compensation of a help for blood moving around the body (Pałka et al., 2023).

Adolescent soccer players who are still growing need more attention for their health. Growth and development in adolescence (10-18 years old) are faster than in childhood (Kontele & Vassilakou, 2021). It includes height and weight gain, VO2 max, aerobic capacity, and muscle strength. Hence, adolescent athletes have different nutritional needs than adolescents who are not athletes, including daily fluid needs (Papaoikonomou et al., 2025). These nutritional needs include daily fluid needs. Previous studies have shown that adolescent athletes are at greater risk of dehydration (Papaoikonomou et al., 2025; Suppiah et al., 2021). Around 80% of youth soccer players in Tasikmalaya have lower water consumption than needed. This condition can affect dehydration in youth soccer players (Marwan & Rohayati, 2020).

The high fluid needs of adolescent athletes need to be met with optimal strategies, one of which is by providing isotonic fluids. To replenish electrolytes, carbohydrates, and other nutrients lost through perspiration during physical activity, isotonic beverages are linked to physical activity (Bendaali et al., 2023). The development of isotonic drinks to manage athlete dehydration was still limited in Indonesia,

especially those that utilize local food ingredients. Sepriani et al. (2024) revealed that infused water using red ginger significantly enhance aerobic endurance (Sepriani et al., 2024). Meanwhile, another study showed that melon can be utilized as a fundamental ingredient for isotonic solutions (Ratri et al., 2024). However, the development of isotonic drinks still needs to be improved to increase product diversity and acceptance by the public, especially athletes.

It is important to consider the nutritional value of local foods, including water, vitamins, minerals, and carbs when using them as isotonic ingredients. Cucumbers and lemons were potential food sources for isotonic drinks that are characterized by high water content, vitamins, and minerals (Indonesia Health Ministry, 2018). Indonesians consume cucumbers in large quantities, particularly as fresh veggies. Meanwhile, according to Maulana (2023), the plentiful production of lemons is not proportional to their consumption, resulting in material waste before it can be used to make other food products, increasing food waste (Maulana et al., 2023). Developing beneficial food products out of the material is one method to solve this issue. Thus, this study aimed to develop an isotonic using local ingredients (cucumber and lemon) and observed how it affects the heart rate of soccer players in Karawang.

METHOD

A total of 25 soccer players were assigned in this pre-experiment one-shot case study. The inclusion criteria were: 1) active players in SSB Kancil Mas Karawang; 2) Aged 10-15 years old; 3) signed the informed consent. The exclusion criteria were the participants who had hypersensitivity/allergy or had any gastric disorder. The subjects provided written consent to participate in the study after being briefed on its objectives and process. All participants who were initially recruited took part in all necessary protocols for the duration of the trial and were included in the final analysis.

They were divided into two groups, Local Food Isotonic (LFI) and Commercial Isotonic (CI). The participants for each group were selected using simple randomization after recruitment. LFI participants accepted the isotonic that contained cucumber (*Cucumis sativus*), lemon (*Citrus lemon*), and honey (20:20:15) with 0,5 g of salt per bottle. LFI participants were given an isotonic drink intervention containing lemon and cucumber as much as 200ml before exercise. The administration of isotonic to both groups was not blinded. This was due to the distinctive color differences in the two different isotonics. The nutritional content of this formulation was tested in the Nutrient Analysis Laboratory of the Nutrition Study Program, at Singaperbangsa Karawang University. CI participants were given an intervention of commercial isotonic drinks as much as 200ml before exercise. Both types of isotonic drinks were drunk 30 minutes before exercise began.

Nutrition status was identified using an anthropometric test (BMI for age). BMI was calculated as weight (kg) divided by height squared (m2). BMI value was standardized by conversion to BMI z-scores in groups defined by age and gender, using the Indonesia Health Ministry Growth Reference (Indonesia Health Ministry, 2020). Categories of nutrition assessment in this study were classified into 5 categories: severely thin, thinness, normal, overweight, and obesity. Heart rate (beats per minute or bpm) was measured after 90 minutes training by gently placing the index and middle fingers on the artery located on the inner wrist. Then the heart rate was counted in 15 seconds using a stopwatch (Seiko) and multiplied 4 times(NHLBI, 2022).

A descriptive analysis was performed in percentage for categoric variables and mean and standard deviation for numeric variables. The normal distribution of the heart rate variable was confirmed using the Shapiro-Wilk test. Therefore, in order to investigate the difference in heart rate between groups, the data was analyzed using the independent t-test with a *p*-value of less than 0.05 was identified to be statistically significant.

RESULTS

The total of 25 participants which were 13 participants in the LFI group and 12 participants in the CI group. The most of participants of LFI were aged 15 years, which was quite different from the CI participants, where most of the participants were 11 years old. For all respondents, half of the participants had normal nutrition status (52%). The number of thin participants (30.7%) was greater than overweight

participants (7.7%) and obese participants (15.4%) in the LFI group. Whilst, in the CI group, the overweight participants (16.8%) and obese participants (8.3%) were greater than the number of underweight participants (severely thin 8.3% and thinness 8.3%) (Table 1).

Table 1 Characteristics of Participants

Nutrition Status	Local Food Isotonic (LFI)		Commercial Isotonic (CI)		Total	
	n	%	n	%	n	%
Age (years)						
10	1	7.7	3	25.0	4	26.7
11	1	7.7	8	66.7	9	60.0
12	1	7.7	0	0.0	1	6.7
14	2	15.4	1	8.3	3	20.0
15	8	61.5	0	0.0	8	53.3
Nutrition Status						
Severely thin	0	0.0	1	8.3	1	4.0
Thinness	4	30.7	1	8.3	5	20.0
Normal	6	46.2	7	58.3	13	52.0
Overweight	1	7.7	2	16.8	3	12.0
Obesity	2	15.4	1	8.3	3	12.0
Total	**13**	**100.0**	**12**	**100.0**	**25**	**100.0**

Table 2 provides the nutrient content for LFI and CI. The macronutrients content of both isotonic, energy, and carbohydrates, were similar. The sugar content of LFI was lower than CI but still encountered the standards of isotonic drinks. The calcium content of LFI was higher than CI. The LFI developed contains 19 mg of vitamin C in a bottle, while CI did not contain it.

Table 2 Comparison of Nutritional Content between Isotonics with Indonesian National Standards (SNI)

Nutrient Content [1]	LFI	CI[2]	SNI for isotonic[3]
Energy (kkal)	53	57	-
Carbohydrate (g)	17	14	-
Sugar (g)	5	14	Minimum 5
Sodium (mg)	194	200	160-200
Potassium (mg)	46	40	25-35
Calcium (mg)	22	8	-
Vitamin C (mg)	19	-	-

[1]Counted in 200 ml; [2]Calculated based on the nutritional value table on the packaging; [3]SNI No. 01-4452-1998

There was a significant difference in heart rate (p=0.005) between the LFI and CI after exercise (Table 3). The decrease in heart rate in the isotonic group and the commercial isotonic group was between 7.315 and 37.095. Following 90 minutes of training, a difference in post-exercise heart rate was observed between the LFI (98±16 bpm) and CI (121±20 bpm) groups (p=0.005). Compared to the LFI group, the CI group's average heart rate was higher, up to 23 bpm.

Table 3 Heart Rate after Intervention

Type of Isotonic	Heart Rate (bpm)		*p*-value
	Mean±STD	Minimum-Maximum	
LFI	98±16	80-136	0.005
CI	121±20	92-156	

DISCUSSION

The objective of this study was to verify the effect of local food isotonic on heart rate after 90 minutes of training. The Local Food Isotonic (LFI) in this study contained cucumber, lemon, and honey, which is known as a food high in fluids, vitamins, and minerals. This formulation has been proven to be an

alternative isotonic based on the nutrient content (Table 2). This study also depicted that the LFI group exhibited a lower mean post-exercise heart rate compared to the CI group. An acknowledgment was a faster decline in heart rate following training. As the stroke volume increases, fewer beats are needed to sustain cardiac output, which lowers the heart's metabolic strain and lowers the resting heart rate(Blanco, 2020).

The result of this study was aligned with Hatta et. al (2016) who stated that isotonic with natural ingredients are better able to improve heart rate after exercise compared to branded isotonics (Hatta et al., 2016). Meanwhile, a study found that homemade sports drinks exhibited the same effects as commercial sports drinks (Zart & Fröhlich, 2019). The potential of isotonic drinks to improve the heart rate of athletes was also explained in the previous studies. According to a study in Yogyakarta, the group that received isotonic drinks, which were made primarily of bananas, was better able to manage electrolytes (potassium, sodium, and chloride) in the blood, in contrast to respondents who only drank water (Afriani et al., 2015). Another study found that isotonic beverages was greater reduce heart rate compared to distilled water (Bechke et al., 2022).

In athletes, fluid loss through sweat during intense or prolonged activity can quickly lead to dehydration. Soccer is a sport with a high level of activity. In a match, athletes can cover a distance of about 10 km. Hence, soccer players had a risk of losing 1.5-2.0% of body mass during the competition (Fernández-Álvarez et al., 2022; Rodríguez-Fernández et al., 2019). The body responds as a thermoregulator by releasing water through perspiration in response to increased energy metabolism and maintaining core temperature. Dehydration will eventually result from the sweat produced during activity, which comes from both metabolism and water from fluid intake (Leão et al., 2022; Putriana et al., 2024).

Post-exercise heart rate increases due to sympathetic nervous activation, reduction of parasympathetic activity, and elevated metabolic demands (Castro-Sepulveda et al., 2018). Dehydration reduces plasma volume and generates increases in cortisol activity and the decline of blood circulation volume and blood pressure, which in turn forces the heart to pump faster to maintain adequate blood flow and oxygen delivery to working muscles through the heart rate rising (Castro-Sepulveda et al., 2018; Leão et al., 2022; Suppiah et al., 2021). The purpose of this increase is to circulate blood throughout the body. Additionally, dehydration impairs the body's ability to cool itself and delays heart rate recovery, indicating greater physiological stress and slower autonomic recovery (Leão et al., 2022; Suppiah et al., 2021).

Heart rate is an indicator that is used to describe physiological adaptations to training. It also showed the physical effort and fatigue level of athletes during training loads (Schneider et al., 2018). Over time, heart rate recovery improves better, reflecting improved autonomic regulation along with potential cardiovascular adaptation (Facioli et al., 2021). Heart rate when an individual is resting is a simple way to assess health prognosis. A lower resting heart rate indicates enhanced cardiovascular fitness and improved myocardial function (Souza et al., 2021). For this mechanism, the enhancement of cardiorespiratory fitness was related to an increase in left ventricular thickness and final systolic volume then possibly generating stroke volume (Letnes et al., 2020).

Isotonic is a rehydration drink that replaces electrolytes lost with sweat released by the body. The present study used some local food as the main ingredients that contained high water, high vitamins, and high minerals (Indonesia Health Ministry, 2018). The formula developed from this study was able to meet the nutritional standards for the isotonic category according to SNI and is similar to the nutrients in commercial isotonic. The cucumber is one of the most commonly grown plants in the gourd family of Cucurbitaceae that contains some essential vitamins, minerals, and antioxidants (Chomicki et al., 2020). Cucumbers are able to provide electrolytes to the body significantly, thus preventing dehydration after exercise (Priscillia et al., 2018). Similar to cucumber, lemon is known as a flavonoid, vitamin, minerals, and carotenoid source that is widely planted (Mamede et al., 2020). Earlier studies proved that the substance content in lemon, such as GABA (Gamma-aminobutyric acid) can calm neurons so that it can improve heart rate (Kato et al., 2014; Tsai et al., 2022). The LFI product developed in this study had the advantage of higher calcium and vitamin C content compared to CI. For the optimal possible muscular contraction and nerve transmission, including regulation of blood pressure, all athletes need to consume sufficient calcium intake (Narayanam et al., 2021). As an antioxidant, vitamin C helps maintain immunological function and

prevent oxidative cell membrane damage, particularly in athletes whose exercise involves high oxygen consumption rates (Leonhardt et al., 2024).

In addition, the heart rate was affected by other factors, including pathological, physiological, psychological, environmental, lifestyle, and genetic factors (Facioli et al., 2021; Manning et al., 2023; Souza et al., 2021). For example, a high degree of aerobic fitness lowers the resting heart rate by reducing the activity of the parasympathetic nervous system. Improvement of cardiovascular health markers, such as healthy blood pressure, a favorable lipid profile, and a decreased risk of morbidity and death in adulthood, are reflected in improved cardiorespiratory fitness during adolescence (Blanco, 2020). In this study, the LFI participants were mostly 15 years old, older than the CI, so there is a possibility that age factors influence the greater decrease in heart rate in the LFI group. A cohort study in 7 - 18 aged athletes presented that the heart rate gradually decreased as the age progressed (Cavarretta et al., 2021). Meanwhile, the difference in percentage of nutritional status categories after randomization in subject selection between LFI and CI groups is likely to have no significant effect on the difference in heart rate. This is proven by several recent studies which stated that there is no significant difference in heart rate based on nutritional status (Machado et al., 2021; Santana et al., 2019; Wang et al., 2024).

It is important to keep in consideration that the current study's design was different from previous ones in order to properly evaluate its findings because it lacked a baseline assessment of cardiovascular parameters before isotonic intake. Another limitation of this study was that it did not measure other variables such as blood electrolytes and thirst hormones. Therefore, further research should be expanded, including control groups, longer interventions, and additional cardiovascular indicators.

CONCLUSION

In conclusion, our findings indicated that the group consuming the formulated local food isotonic beverage had a lower mean post-exercise heart rate compared to the group consuming the commercial isotonic beverage. These findings provided a preliminary basis for considering local food isotonic as an alternative, yet further research is still needed. Additional research is still required to examine the other indicators of dehydration prevention and using a control group.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

HEALTH CODE OF ETHICS

The ethics of this study were declared by Komisi Etik Penelitian Universitas Esa Unggul with number 0923-12.008 /DPKE-KEP/FINAL-EA/UEU/I/2024..

REFERENCE

Afriani, Y., Putri, K. R., Penggalih, M. H. S. T., Kandarina, I., & Sofro, Z. M. (2015). Effect of banana isotonic drink to maintain hydration through urine and blood electrolytes. *Pakistan Journal of Nutrition*, *14*(8), 453–456. https://doi.org/10.3923/pjn.2015.453.456

Bechke, E. E., Zaplatosch, M. E., Choi, J. Y., & Adams, W. M. (2022). Utility of an Isotonic Beverage on Hydration Status and Cardiovascular Alterations. *Nutrients*, *14*(6). https://doi.org/10.3390/nu14061286

Bendaali, Y., Vaquero, C., Escott, C., González, C., & Morata, A. (2023). Isotonic Drinks Based on Organic Grape Juice and Naturally Flavored with Herb and Spice Extracts. *Beverages*, *9*(2). https://doi.org/10.3390/beverages9020049

Blanco, P. (2020). Rationale for using the velocity–time integral and the minute distance for assessing the stroke volume and cardiac output in point-of-care settings. In *Ultrasound Journal* (Vol. 12, Issue 1). Springer. https://doi.org/10.1186/s13089-020-00170-x

Cariolo, A., Del Coso, J., Argudo, F. M., & Borges-Hernandez, P. J. (2019). Effects of rehydration on the physical and technical condition in soccer players. *Apunts Medicina de l'Esport*, *54*(201), 5–11. https://doi.org/10.1016/j.apunts.2018.09.004

Castro-Sepulveda, M., Ramirez-Campillo, R., Abad-Colil, F., Monje, C., Peñailillo, L., Cancino, J., & Zbinden-Foncea, H. (2018). Basal mild dehydration increase salivary cortisol after a friendly match in young elite soccer players. *Frontiers in Physiology*, *9*(SEP). https://doi.org/10.3389/fphys.2018.01347

Cavarretta, E., Sciarra, L., Biondi-Zoccai, G., Maffessanti, F., Nigro, A., Sperandii, F., Guerra, E., Quaranta, F., Fossati, C., Peruzzi, M., Pingitore, A., Stasinopoulos, D. M., Rigby, R. A., Adorisio, R., Saglietto, A., Calò, L., Frati, G., & Pigozzi, F. (2021). Age-Related Electrocardiographic Characteristics of Male Junior Soccer Athletes. *Frontiers in Cardiovascular Medicine*, *8*. https://doi.org/10.3389/fcvm.2021.784170

Chomicki, G., Schaefer, H., & Renner, S. S. (2020). Origin and domestication of Cucurbitaceae crops: insights from phylogenies, genomics and archaeology. In *New Phytologist* (Vol. 226, Issue 5, pp. 1240–1255). Blackwell Publishing Ltd. https://doi.org/10.1111/nph.16015

Priscillia, I. E., Chukwuemeka, O. E., Christian Ejike, O., Adamma, A. R., Athanatius, O. O., Nwabunwanne, O. V., Chukwuemeka, U. M., Kalu, A. A., Chukwuemeka, M. S., & Priscillia, E. I. (2018). Effect of Cucumber Consumption on Plasma Electrolytes Profile Levels in Apparently Healthy Students of College of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, Anambra State, Nigeria. *Ezeugwunne et al. World Journal of Pharmaceutical Research World Journal of Pharmaceutical Research SJIF Impact Factor*, *7*(11), 60–69. https://doi.org/10.20959/wjpr201811-12443

Facioli, T. P., Philbois, S. V., Gastaldi, A. C., Almeida, D. S., Maida, K. D., Rodrigues, J. A. L., Sánchez-Delgado, J. C., & Souza, H. C. D. (2021). Study of heart rate recovery and cardiovascular autonomic modulation in healthy participants after submaximal exercise. *Scientific Reports*, *11*(1). https://doi.org/10.1038/s41598-021-83071-w

Fernández-Álvarez, M. D. M., Cachero-Rodríguez, J., Leirós-Díaz, C., Carrasco-Santos, S., & Martín-Payo, R. (2022). Evaluation of Water Intake in Spanish Adolescent Soccer Players during a Competition. *Journal of Human Kinetics*, *83*(1), 59–66. https://doi.org/10.2478/hukin-2022-0051

Fortes, L. S., Nascimento-Júnior, J. R. A., Mortatti, A. L., Lima-Júnior, D. R. A. A. de, & Ferreira, M. E. C. (2018). Effect of Dehydration on Passing Decision Making in Soccer Athletes. *Research Quarterly for Exercise and Sport*, *89*(3), 332–339. https://doi.org/10.1080/02701367.2018.1488026

Gotthold, C. (2020). *Dietary Sodium Intake and Sweat Sodium Losses in Endurance Dietary Sodium Intake and Sweat Sodium Losses in Endurance Athletes Athletes* [West Chester University]. https://digitalcommons.wcupa.edu/all_theses

Hatta, M., Susanto, H., & Rahfilludin, M. Z. (2016). *Perbandingan pemberian air kelapa muda (cocos nucifera l) dengan isotonik terhadap denyut nadi dan VO2maks atlet remaja*. *4*, 71.

Indonesia Health Ministry. (2018). *Tabel Komposisi Pangan Indonesia 2017*. Indonesia Health Ministry.

Indonesia Health Ministry. (2020). *Children Anthropometric Standard*. Indonesia Health Ministry.

Kato, Y., Domoto, T., Hiramitsu, M., Katagiri, T., Sato, K., Miyake, Y., Aoi, S., Ishihara, K., Ikeda, H., Umei, N., Takigawa, A., & Harada, T. (2014). Effect on blood pressure of daily lemon ingestion and walking. *Journal of Nutrition and Metabolism*, *2014*. https://doi.org/10.1155/2014/912684

King, M., Kimble, R., Brown, M., McCafferty, S., & Lithgow, H. (2024). Perceptual Health and Wellbeing, Self-Reported Sleep, and Hydration Status in Youth Soccer Players During Competition. *Journal of Nutrition and Metabolism*, *2024*(1). https://doi.org/10.1155/2024/5086660

Klimesova, I., Krejci, J., Botek, M., McKune, A. J., Jakubec, A., Neuls, F., Sladeckova, B., & Valenta, M. (2022). Prevalence of Dehydration and the Relationship with Fluid Intake and Self-Assessment of Hydration

Status in Czech First League Soccer Players. *Journal of Human Kinetics*, *82*(1), 101–110. https://doi.org/10.2478/hukin-2022-0035

Kontele, I., & Vassilakou, T. (2021). Nutritional risks among adolescent athletes with disordered eating. In *Children* (Vol. 8, Issue 8). MDPI. https://doi.org/10.3390/children8080715

Leão, C., González-Fernández, F. T., Ceylan, H. İ., Clemente, F. M., Nobari, H., Camões, M., & Carral, J. M. C. (2022). Dehydration, Wellness, and Training Demands of Professional Soccer Players during Preseason. *BioMed Research International*, *2022*. https://doi.org/10.1155/2022/8054449

Leonhardt, T. P. M., Bristol, A., McLaurin, N., Forbes, S. C., Tanaka, H., Frings-Meuthen, P., Pesta, D., Rittweger, J., & Chilibeck, P. D. (2024). Dietary Intake of Athletes at the World Masters Athletics Championships as Assessed by Single 24 h Recall. *Nutrients*, *16*(4). https://doi.org/10.3390/nu16040564

Letnes, J. M., Nes, B., Vaardal-Lunde, K., Slette, M. B., Mølmen-Hansen, H. E., Stian, ;, Aspenes, T., Støylen, A., Wisløff, U., & Avard Dalen, ; H. (2020). Left Atrial Volume, Cardiorespiratory Fitness, and Diastolic Function in Healthy Individuals: The HUNT Study, Norway. *Journal of the American Heart Association*, *9*. https://doi.org/10.1161/JAHA.119

Machado, E. A., Farinatti, P., Sicuro, F. L., Rodrigues, F., Bouskela, E., & Collett-Solberg, P. F. (2021). Daily physical activity, cardiorespiratory fitness, nutritional status, endothelial function, and autonomic modulation in school-age adolescents: A principal component analysis. *Obesity Research and Clinical Practice*, *15*(3), 205–211. https://doi.org/10.1016/j.orcp.2021.04.004

Mamede, A. M. G. N., Coelho, C. C. de S., Freitas-Silva, O., Barboza, H. T. G., & Soares, A. G. (2020). Lemon. In *Nutritional Composition and Antioxidant Properties of Fruits and Vegetables* (pp. 377–392). Elsevier. https://doi.org/10.1016/B978-0-12-812780-3.00023-4

Manning, C. N., Morrissey, M. C., Langan, S. P., Stearns, R. L., Huggins, R. A., Curtis, R. M., Sekiguchi, Y., Laxminarayan, S., Reifman, J., & Casa, D. J. (2023). Fluid Replacement Strategies and Heart Rate Variability Recovery Following Prolonged Exercise in the Heat and Mild Dehydration. *Physiologia*, *3*(1), 98–112. https://doi.org/10.3390/physiologia3010008

Marwan, I., & Rohayati, N. (2020). Overcoming Hydrauly Adolescent Athletes: Before And After Football Training. *Journal of Physical Education Research*, *7*(1), 20–30. www.joper.org

Maulana, I., Alif Asran, M., & Maulana Ash-Habi, R. (2023). *Implementation of Sustainable Development Goals (SDGs) No. 12: Responsible Production and Consumption by Optimizing Lemon Commodities and Community Empowerment to Reduce Household Waste*. https://ejournal.bumipublikasinusantara.id/index.php/ajcse

Narayanam, H., Chinni, S. V., & Samuggam, S. (2021). The Impact of Micronutrients-Calcium, Vitamin D, Selenium, Zinc in Cardiovascular Health: A Mini Review. In *Frontiers in Physiology* (Vol. 12). Frontiers Media S.A. https://doi.org/10.3389/fphys.2021.742425

NHLBI. (2022, March 24). *How the Heart Works*. National Heart, Lung, and Blood Institute. https://www.nhlbi.nih.gov/health/heart/heart-beats

Pałka, T., Koteja, P. M., Tota, Ł., Rydzik, Ł., Kopańska, M., Kaczorowska, I., Javdaneh, N., Mikulakova, W., Wolski, H., & Ambroży, T. (2023). The Influence of Various Hydration Strategies (Isotonic, Water, and No Hydration) on Hematological Indices, Plasma Volume, and Lactate Concentration in Young Men during Prolonged Cycling in Elevated Ambient Temperatures. *Biology*, *12*(5). https://doi.org/10.3390/biology12050687

Papaoikonomou, G., Apergi, K., & Malisova, O. (2025). Children, Adolescents and Urine Hydration Indices—A Systematic Literature Review on Athletes and Non-Athletes. In *Children* (Vol. 12, Issue 2). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/children12020171

Putriana, D., Mukharromah, H., Solichah, K. M., & Nugroho, A. (2024). Asupan Cairan dan Tekanan Darah Periode Latihan pada Atlet Sepak Bola Remaja Dittasari Putriana * , Hidayah Mukharromah, Kurnia Mar'atus Solichah, Agung Nugroho. *Atlet Sepak Bola Remaja)*, *2*(2), 2289.

Ratri, P. R., Yuanta, Y., & Puspita, S. D. (2024). The analysis of nutritive value, vitamin, and minerals content of natural isotonic beverages formulated from Smart Green House Melon. *IOP Conference Series: Earth and Environmental Science*, *1338*(1). https://doi.org/10.1088/1755-1315/1338/1/012038

Rodríguez-Fernández, A., Sanchez-Sanchez, J., Ramirez-Campillo, R., Nakamura, F. Y., Rodríguez-Marroyo, J. A., & Villa-Vicente, J. G. (2019). Relationship Between Repeated Sprint Ability, Aerobic Capacity, Intermittent Endurance, and Heart Rate Recovery in Youth Soccer Players. *Journal of Strength and Conditioning Research*, *33*(12), 3406–3413. https://doi.org/10.1519/JSC.0000000000002193

Rollo, I., Randell, R. K., Baker, L., Leyes, J. Y., Leal, D. M., Lizarraga, A., Mesalles, J., Jeukendrup, A. E., James, L. J., & Carter, J. M. (2021). Fluid balance, sweat na+ losses, and carbohydrate intake of elite male soccer players in response to low and high training intensities in cool and hot environments. *Nutrients*, *13*(2), 1–11. https://doi.org/10.3390/nu13020401

Santana, M. D. R., Kliszczewicz, B., Vanderlei, F. M., Monteiro, L. R. L., Martiniano, E. C., De Moraes, Y. M., Mangueira, L. B., Alcantara, G. C., Da Silva, J. R. A., Benjamim, C. J. R., Oliveira, F. R., & Valenti, V. E. (2019). Autonomic responses induced by aerobic submaximal exercise in obese and overweight adolescents. *Cardiology in the Young*, *29*(2), 169–173. https://doi.org/10.1017/S1047951118002007

Schneider, C., Hanakam, F., Wiewelhove, T., Döweling, A., Kellmann, M., Meyer, T., Pfeiffer, M., & Ferrauti, A. (2018). Heart rate monitoring in team sports-A conceptual framework for contextualizing heart rate measures for training and recovery prescription. *Frontiers in Physiology*, *9*(MAY). https://doi.org/10.3389/fphys.2018.00639

Sepriani, R., Bafirman, B., Deswandi, D., Syampurma, H., Effendi, H., & Pratiwi, M. D. (2024). The Effectiveness of Ginger-Infused Water on Aerobic Endurance: A Randomized Control Trial La eficacia del agua con jengibre sobre la resistencia aeróbica: un ensayo de control aleatorio. In *Retos* (Vol. 53). https://recyt.fecyt.es/index.php/retos/index

Souza, H. C. D., Philbois, S. V., Veiga, A. C., & Aguilar, B. A. (2021). Heart Rate Variability and Cardiovascular Fitness: What We Know so Far. In *Vascular health and risk management* (Vol. 17, pp. 701–711). NLM (Medline). https://doi.org/10.2147/VHRM.S279322

Suppiah, H. T., Ng, E. L., Wee, J., Taim, B. C., Huynh, M., Gastin, P. B., Chia, M., Low, C. Y., & Lee, J. K. W. (2021). Hydration status and fluid replacement strategies of high-performance adolescent athletes: An application of machine learning to distinguish hydration characteristics. *Nutrients*, *13*(11). https://doi.org/10.3390/nu13114073

Tsai, C. C., Lin, L. Y., & Chou, L. C. (2022). The effects of lactic acid bacteria-fermented lemon juice on blood pressure regulation and allergic responses in rodents. *ScienceAsia*, *48*(2), 181–187. https://doi.org/10.2306/scienceasia1513-1874.2022.026

Wang, Y., He, Z., Fan, B., Liu, L., & Chi, A. (2024). *Effects of acute endurance exercise on heart rate variability in young males with different body mass index*. https://doi.org/10.21203/rs.3.rs-4563761/v1

Zart, S., & Fröhlich, M. (2019). Effects of commercial isotonic sports drinks during intermittent exertion. *International Journal of Kinesiology and Sports Science*, *7*(1), 1–8. https://doi.org/10.7575/aiac.ijkss.v.7n.1p.1